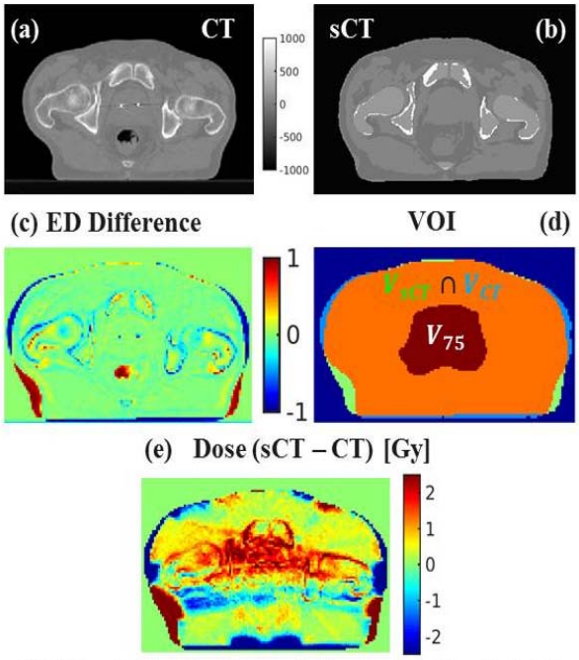
Ingenia) with in-house-built flat table top. The sCT **(b)** were generated by the technique described by Schadewaldt et al, using mDixon acquisition and model-based segmentation to assign fixed HU to 5 tissue classes. The RT plans were recalculated in Monaco v5.10 (Elekta) on sCT without any further optimization utilizing the delineations from the planning CT after rigid registration of CT on sCT. The alignment (translation-only) of isocenters of the two plans allowed voxelwise dose comparison and γ-analysis.
CTs and sCTs are inherently different, as they are acquired at different time points and, furthermore, the patient anatomy can slightly vary during the positioning on CT and MR. Fig **(c)** highlights the differences, in terms of ED, of sCT minus CT for a transversal slice of one of the patients: differences in body contour and bone structure can be observed, as well as the lack of prostate markers and air pockets on sCT. VOIs **(d)** defined as the intersection of the body contour of CT and sCT (*VBody*) and as 75% (*V75*) of the prescribed dose (77 Gy) are considered in order to minimize such physiological differences during the comparison **(e)**.



CT **(a)** and sCT **(b)** with the relative Electron Density (ED) difference **(c)**. Fig. **(d)** highlights the VOIs utilized to characterize the voxelwise dose deviations **(e)**.

Results: The dose on sCT results in a slightly systematic higher dose (1.3%, 0.9%) in *V75* and in *VBody*, respectively, when compared to CT, as shown in the Table in terms of dose difference and relative dose difference over the whole study population. The highest average dose calculated in a patient (i.e. worst case scenario) is lower than 1.5 and 0.2 Gy in *V75* and *VBody* respectively. In this type of comparison, differences in patient positioning between CT and sCT contribute to the observed difference in dose.

	Average Deviation $sCT - CT$ [Gy]	Average Rel Deviation $\frac{sCT-CT}{CT}$ [%]	$\gamma_{3\%/3mm}$ [%]	$\gamma_{2\%/2mm}$ [%]
$V_{75\%}$	0.92 ± 0.25	1.30 ± 0.36	99.3 ± 0.8	94.5 ± 4.1
V_{Body}	0.10 ± 0.04	0.86 ± 0.58	98.8 ± 0.9	95.8 ± 2.3

Average Deviation, Average Relative Deviation and Gamma passed rate (mean ± std) over all the patients for $V_{75\%}$ & V_{Body}.

Conclusion: This study evaluated the accuracy of dose calculation on sCT MR-only generated for prostate IMRT plans. Further investigations on the contributions to the observed differences are subject of current and on going research.

EP-1842

A dosimetric analysis of MRI only treatment planning of the brain

E. Goodwin[1], D. Bird[1], J. Lilley[1], R. Speight[1]
[1]*St James Institute of Oncology, Medical Physics and Engineering, Leeds, United Kingdom*

Purpose or Objective: MRI only treatment planning is gaining interest as it removes errors associated with image registration from the planning pathway. As access to MRI becomes more widespread in radiotherapy departments, it will become more feasible to carry out MRI only planning. This study aimed to assess the dosimetric accuracy of treatment plans calculated using an MRI only approach for 3D conformal radiotherapy (3DCRT) and volumetric modulated arc therapy (VMAT) brain treatments.

Material and Methods: Ten retrospective patients (five glioblastoma multiforme (GBM) patients treated with 3DCRT, and five meningioma patients treated with VMAT) were selected. A synthetic CT (sCT) was created for each patient by manually contouring the patient external, bone and sinus. The electron density (ED) of the patient, bone and sinus were forced to 1.0, 1.68 and 0.11 g/cm3 respectively, these values were derived by contouring the structures in ten representative CT study-sets. A treatment plan was calculated for each patient using the sCT, the original planning CT, and using the MRI study-set with a homogenous ED of unity. The resulting dose distributions were quantitatively analysed using the dose to the isocentre and clinically relevant DVH statistics (fig 2). A qualitative analysis of dose difference maps and DVHs was also undertaken.

Results: A paired, two-tailed student t-test found that the dose to the isocentre was statistically indistinguishable ($p<0.05$) between the sCT and the CT based dose distributions for all plans, whereas this was not the case for the homogenous density calculation. A mixed linear regression analysis of the DVH statistics showed that the ED map was a significant predictor of the dose values ($p<0.05$) when comparing CT to homogenous density, but did not find the ED to be a significant predictor of the DVH statistics when comparing sCT and CT calculated dose distributions.
The qualitative analysis supported these findings: the dose difference maps showed that there was generally good agreement between the CT and the sCT calculated dose distributions, with the main areas of difference between them occurring near the patient external (see fig. 1). Comparison of the CT and sCT DVHs also showed them to be similar, with marked differences to those calculated assuming homogenous density

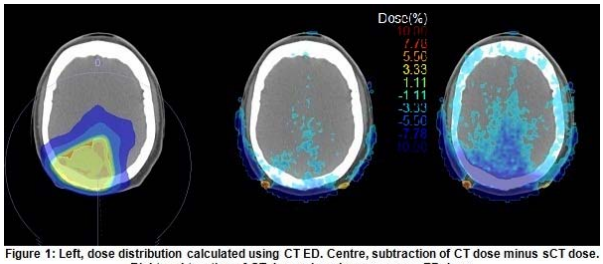


Figure 1: Left, dose distribution calculated using CT ED. Centre, subtraction of CT dose minus sCT dose. Right, subtraction of CT dose minus homogeneous ED dose.

Meningioma Cohort		Isocentre	V98 (>90%)	V95 (>95%)	V5 (<105%)	V2 (<107%)
Patient 1	CT	1.013	0.980	0.987	1.042	1.048
	sCT	1.007	0.958	0.970	1.006	1.048
	Homogenous	1.040	1.004	1.015	1.087	1.097
Patient 2	CT	1.005	0.953	0.980	1.077	1.087
	sCT	1.005	0.953	0.980	1.077	1.087
	Homogenous	0.998	0.956	0.988	1.091	1.100
Patient 3	CT	0.974	0.922	0.949	1.041	1.058
	sCT	0.991	0.916	0.941	1.047	1.060
	Homogenous	1.008	0.945	0.975	1.068	1.084
Patient 4	CT	1.030	0.980	0.991	1.056	1.065
	sCT	1.001	0.943	0.959	1.044	1.055
	Homogenous	1.039	1.011	1.026	1.120	1.134
Patient 5	CT	1.000	0.967	0.981	1.045	1.053
	sCT	1.008	0.960	0.975	1.052	1.058
	Homogenous	1.036	1.008	1.023	1.096	1.105
GBM Cohort		Isocentre	V98 (>90%)	V95 (>95%)	V5 (<105%)	V2 (<107%)
Patient 1	CT	1.000	0.860	0.882	1.162	1.189
	sCT	1.009	0.870	0.890	1.167	1.196
	Homogenous	1.035	0.884	0.904	1.191	1.218
Patient 2	CT	1.000	0.863	0.881	1.100	1.114
	sCT	1.003	0.867	0.885	1.104	1.118
	Homogenous	1.043	0.884	0.902	1.142	1.160
Patient 3	CT	1.000	0.856	0.875	1.085	1.097
	sCT	0.997	0.841	0.865	1.082	1.095
	Homogenous	1.016	0.874	0.893	1.129	1.139
Patient 4	CT	1.000	0.808	0.833	1.090	1.098
	sCT	1.012	0.821	0.844	1.095	1.103
	Homogenous	1.024	0.837	0.859	1.139	1.149
Patient 5	CT	1.000	0.855	0.869	1.117	1.141
	sCT	1.009	0.855	0.870	1.117	1.140
	Homogenous	1.016	0.877	0.893	1.153	1.179

Figure 2: Dose to isocentre and DVH statistics for all Meningioma (VMAT) and GBM (3DCRT) patients. Doses are expressed as a fraction of the prescription dose.

Conclusion: The dosimetric accuracy of treatment plans calculated using a forced density technique is equivalent to planning on CT and does not appear to be a limiting factor for MRI only planning of brain patients.

EP-1843

Synthetic CT calculation from low-field MRI: feasibility of an MRI-only workflow for glioblastoma RT

N. Nesvacil[1], H. Herrmann[1], E. Persson[2], C. Siversson[3], B. Knäusl[4], P. Kuess[5], L.E. Olsson[6], D. Georg[5], T. Nyholm[7]

[1]*Medical University of Vienna, Department of Radiotherapy & Comprehensive Cancer Center, Vienna, Austria*

[2]*Skåne University Hospital, Department of Radiation Physics, Lund, Sweden*

[3]*Spectronic Medical AB Helsingborg & Lund University, Department of Medical Radiation Physics, Malmö, Sweden*

[4]*Medical University of Vienna, Department of Radiotherapy & Christian.Doppler Laboratory for Medical Radiation Research for Radiation Oncology, Vienna, Austria*

[5]*Medical University of Vienna, Department of Radiotherapy & Christian Doppler Laboratory for Medical Radiation Research for Radiation Oncology, Vienna, Austria*

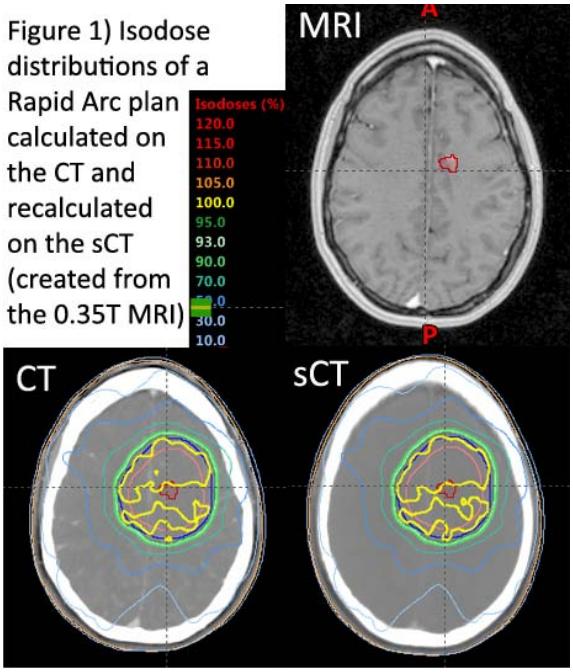
[6]*Lund University, Department of Medical Radiation Physics, Malmö, Sweden*

[7]*Umea University, Department of Radiation Sciences-Radiation Physics, Umea, Sweden*

Purpose or Objective: An MRI-only EBRT treatment planning workflow based on synthetic CTs (sCT) could help reduce MRI/CT registration uncertainties, while taking into account the improved soft tissue contrast of MRI for volumes definition, and reducing patient scanning time by avoiding the use of multiple imaging modalities for RT planning.
The aim of this pilot study was to develop a model for creating sCTs for glioblastoma, based on commercial software and to further explore the potential of a low-field open MRI scanner dedicated to RT.

Material and Methods: Using a clinical protocol optimized for RT planning T1 weighted MR (0.35T, Siemens Magnetom C!) and CT scans (Siemens Somatom Definition AS) were acquired for 6 patients with slice thickness of 4mm (MRI) and 2mm (CT). Target and OAR (brainstem, chiasm, cochlea, eye, hippocampus, lens and optic nerve) structures were delineated on MRI. The CTV was defined as the GTV (resection cavity) isotropically expanded by 1.5cm. For PTV the CTV was expanded by 0.5cm.
Synthetic CTs were generated from the MRI by the commercial MriPlanner software (Spectronic Medical AB, Helsingborg, Sweden) utilizing the Statistical Decomposition Algorithm (Siversson et al, Med Phys. 2015; 42).
The sCTs were tested for dosimetric validity compared to CT images. Delineated structures were transferred from MRI to CT via rigid image registration. For each patient a 6MV RapidArc plan was created on the CT using Eclipse (Varian Med. Sys.) and recalculated on the rigidly registered sCT using the same number of monitor units. The prescribed dose to D50% of the PTV was 60Gy in 30fx.

Results: Visual comparison showed good agreement between CT and sCT. (Fig. 1) The slightly blurred appearance of the sCT is an effect of the lower slice resolution of the MRI compared to the CT. Dosimetric results are reported in Table 1.



	Average Mean ΔDose (%)	Standard Dev (%)
PTV	-0.18	0.59
CTV	-0.21	0.63
GTV	-0.19	0.62
Brainstem	-0.18	0.85
Chiasm	-0.32	0.67
Cochlea Left	0.20	0.47
Cochlea Right	-0.36	0.78
Eye Left	0.17	1.57
Eye Right	-0.09	1.38
Hippocampus Left	-0.08	0.29
Hippocampus Right	-0.01	0.11
Lens Left	0.13	1.85
Lens Right	0.23	3.07
Optic Nerve Left	-0.04	1.46
Optic Nerve Right	-0.03	0.76

Conclusion: In this pilot study the MriPlanner software, which was previously verified for prostate images acquired at higher field strengths, was uccessfully applied to glioblastoma cases.
In the present study a patient fixation device was used for CT acquisition but not for MRI. This may lead to slight geometrical differences between CT and MRI, which may propagate to the dosimetric analysis. Nevertheless, the results of this study indicate that low-field MRI is suitable for